Optimal transport and applications in statistical analysis

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Optimal transport (OT) originated in 1781 with Gaspard Monge's «Mémoire sur la théorie des déblais et des remblais», which posed the problem of the optimal displacement of a pile of sand. This theory reemerged in the 1940s with Leonid Kantorovich, who introduced a relaxed formulation of OT consisting of finding the most efficient (minimal cost) way to transform one distribution into another. OT then offers a versatile framework for measuring (dis)similarities, interpolating and aligning distributions, while explicitly taking into account the geometry of their underlying space. Today, OT stands as a rich mathematical theory and applied research, at the intersection of probability, optimisation and partial differential equations, with applications to data such as point clouds, images, words, and continuous data. In this talk, we introduce the fundamental principles of OT (Monge and Kantorovich formulations, Brenier's theorem and numerical methods) and conclude by illustrating how OT can be effectively exploited in statistical data analysis applications.